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E.V.G.S Emergency Vehicle Guidance System

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ABSTRACT

Every day, traffic conditions in both rural and urban areas are getting worse and worse. In such situations, if there is an emergency like a medical crisis, fire, road accident, or natural disaster, emergency vehicles need to move through heavy traffic. At these critical times, even a difference of a few milliseconds can mean the difference between life and death. To deal with this problem, we need to take effective steps and create a strong system that helps guide emergency vehicles to find the best path, even when traffic is getting worse.

INTRODUCTION

In today's fast-growing urban areas, traffic jams have become a big problem for emergency services. Ambulances, firefighters, and police cars often get stuck at traffic lights, causing delays that can cost valuable time and even lead to loss of life. To solve this issue, the Emergency Vehicle Guidance System (EVGS) has been introduced.

It is an IoT-based solution that combines GPS, microcontroller-controlled traffic signals, and wireless communication methods like GSM, Wi-Fi, and MQTT to give priority to emergency vehicles. The system uses GPS to track the location of emergency vehicles and sends this information to nearby traffic controllers. When an emergency vehicle is approaching an intersection, the system automatically switches the traffic light to green in that direction, allowing the vehicle to pass through more quickly. This innovative system improves the effectiveness of emergency responses and supports the development of Smart City infrastructure, aiming to connect intelligent traffic management with IoT technology.

KEYWORDS

Smart Traffic Management, Iot Communication, MQTT Protocol, Real Time Signal Control, Road Safety Enhancement .

LITERATURE REVIEW

Several studies and projects have been suggested in the area of smart traffic management and helping emergency vehicles get priority:

Smart Traffic Light System using IoT (2019) – This project suggested using IoT technology for traffic lights that change their timing based on how many cars are around, but it didn’t include a special way for emergency vehicles to get through faster.

GPS and GSM-based Vehicle Tracking System (2020) – This project used GPS to track vehicles and sent their location information through GSM modules, which helped set up a system to know where emergency vehicles were.

Intelligent Transportation Systems (ITS) (2021) – This suggested using communication between vehicles and road infrastructure (V2I) for better traffic control, but it needed expensive network setup.

Emergency Vehicle Priority System using RF Communication (2022) – This used short-range radio signals but had problems with how far it could reach and interference from other signals.

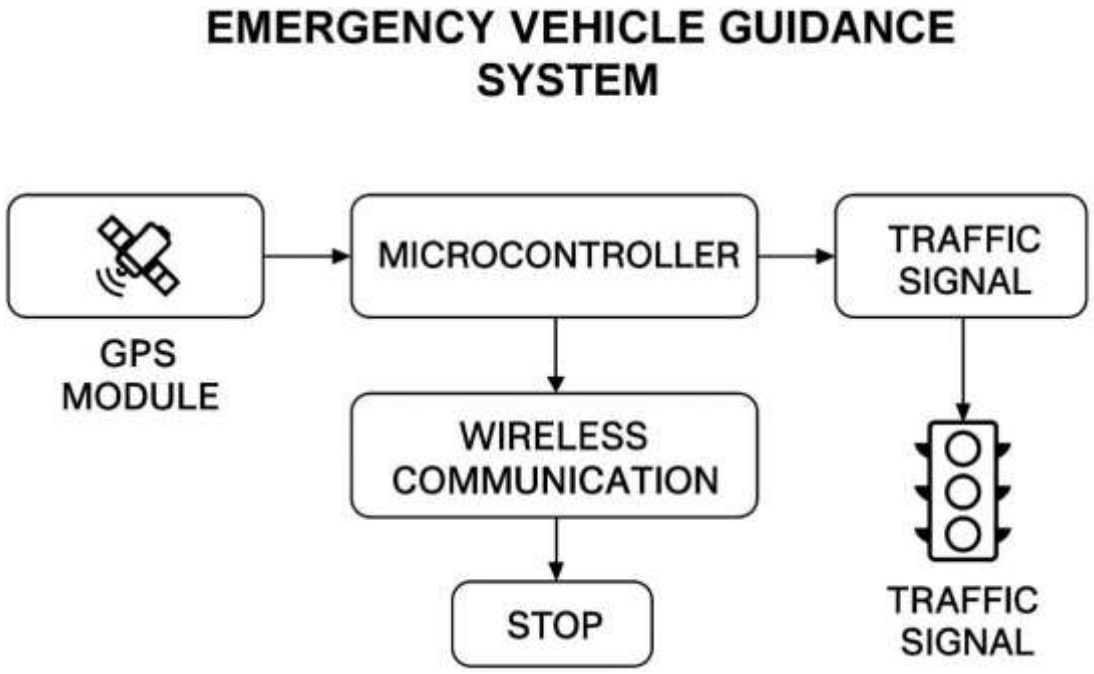
IoT-enabled Emergency Vehicle System using MQTT Protocol (2023) – This focused on using the MQTT protocol for cloud communication, making data transfer quicker and easier to scale.

Looking at these projects, it's clear that using GPS, IoT, and wireless communication methods can be a good and affordable way to create a dependable system for guiding emergency vehicles.

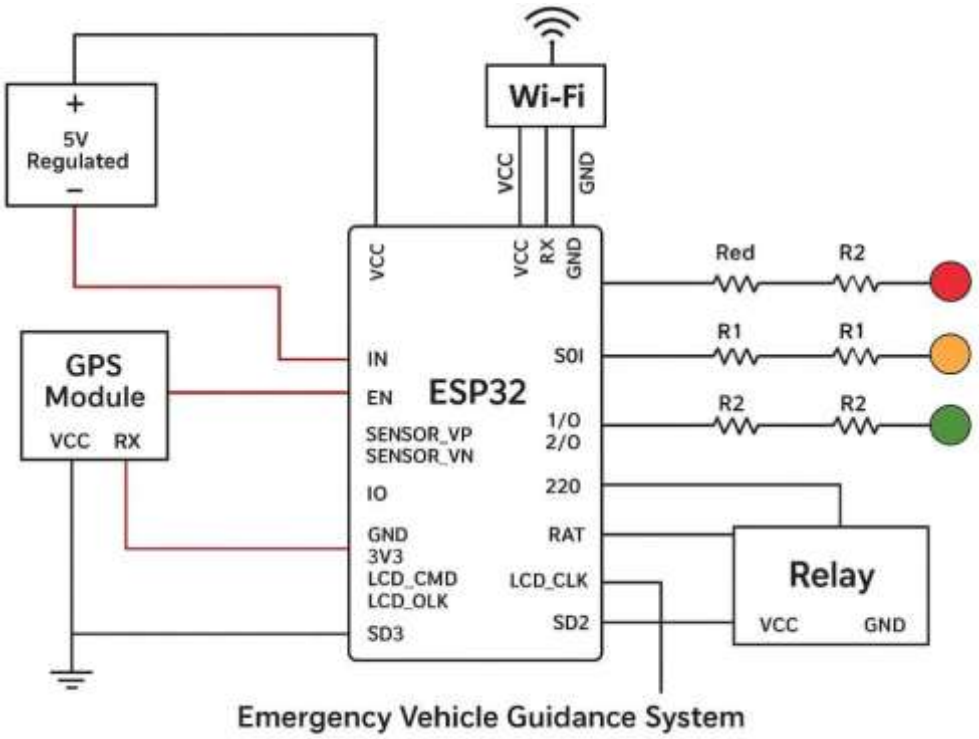
SYSTEM ARCHITECTURE

The system uses an ESP32 device placed in the emergency vehicle, which has a GPS module that sends the vehicle's location continuously through the internet using Wi-Fi or MQTT. At every traffic light, another ESP32 gets this location data and detects when an emergency vehicle is coming. Then, the system controls the traffic lights by turning on the green light for the emergency vehicle and stopping the lights in other directions. Once the vehicle has passed, the traffic lights go back to their usual schedule. This helps emergency vehicles move quickly and without delays through busy areas.

BLOCK DIAGRAM



CIRCUIT DIAGRAM



Emergency Vehicle Guidance System

HARDWARE COMPONENTS & SPECIFICATIONS

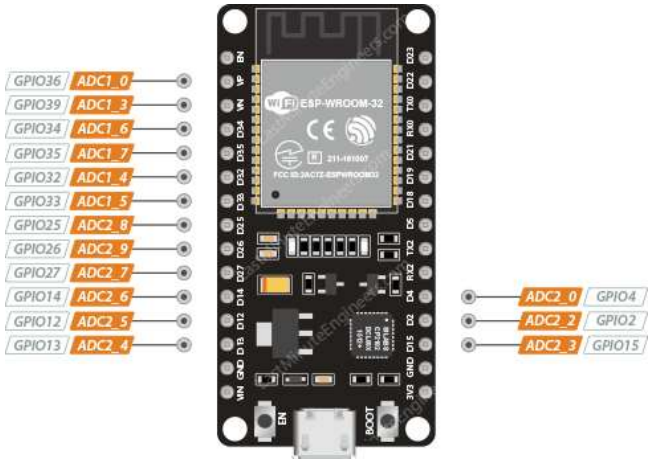
1 - ESP32 Microcontroller

The ESP32 is the main brain of our project.

It has Wi-Fi built right inside, so it can easily send and receive information over the internet without needing any extra part.

Why We Use It:

- It handles the GPS location data.
- It sends signals to the traffic lights system.
- It connects to the network using Wi-Fi or MQTT. Important Features:
- Works with 3.3 volts.
- Has two processors that can run up to 240 MHz.
- Has built-in Wi-Fi and Bluetooth.
- Has 34 pins for connecting other parts.
- Supports communication methods like Serial, I2C, and SPI.



2 - GPS Module (NEO-6M / uBlox GPS)

The GPS module gives the current position of the emergency vehicle.

It keeps sending the location details like latitude and longitude to the ESP32 all the time. Why We Use It:

- To know where the emergency vehicle is.
- To check if it is near a traffic signal.

Features:

- Works with 3.3 volts to 5 volts.
- Accurate up to about 2.5 meters.
- Communicates through UART using TX and RX pins.
- Sends one data reading every second by default.

3 - Relay Module (4 Channel / 2 Channel)

The relay acts like an electrical switch. It helps the ESP32 control the traffic lights without dealing with high voltage wires directly.

Why We Use It:

- ESP32 cannot work with high voltage.
- The relay makes the system safer and keeps parts separate. Features:
- Needs 5 volts to operate.
- Can handle up to 250 volts AC and 10 amps.
- It is an electromagnetic relay.
- It is electrically isolated (Optocoupler is suggested for safety).

4 - Traffic Signal Lights (Red, Yellow, Green)

These are the standard lights you see at road crossings.

We connect them to the relay so the system can change the signals automatically. Features:

- Each light uses about 10 watts of power.
- Has red, yellow, and green colors.
- Controlled by turning them on or off using the relay.

5 – POWER MODULE

- ESP32: 3.3 volts
- GPS Module: 3.3 volts or 5 volts
- Relay Module: 5 volts
- Traffic Lights: 12 volts AC (depends on the model)

We use voltage regulator LM2596 to convert battery or power adapter voltage to the correct levels.

How These Parts Work Together

1. The GPS module gives the current location of the emergency vehicle to the ESP32.
2. The ESP32 sends this location to the traffic control system using Wi-Fi and MQTT.
3. When the vehicle is close to a traffic signal:

- The relay turns the traffic signal green in the direction of the vehicle.
- All other lights turn red.

4. Once the vehicle passes through the intersection, the traffic lights return to normal automatically

WORKING

The Emergency Vehicle Guidance System (EVGS) functions by identifying the current location of an emergency vehicle and adjusting traffic signals to give it priority. This system uses a combination of an ESP32 microcontroller, a GPS module, a Wi-Fi network, and a relay-based traffic signal control system to perform its tasks.

Step-by-Step Operation:

1. GPS Tracking of Emergency Vehicle

The GPS module, installed in the emergency vehicle, constantly sends the vehicle's latitude and longitude to the ESP32 microcontroller.

2. Data Transfer Through Wi-Fi or MQTT

The ESP32 sends the location data to the traffic control system using Wi-Fi or the MQTT communication protocol.

3. Identifying the Nearest Traffic Signal

The system determines which traffic intersection the vehicle is approaching by comparing:

- The current GPS coordinates of the vehicle
- The pre-stored GPS coordinates of nearby intersections

4. Signal Preemption (Priority Mode Activation)

When the system detects that the vehicle is near a traffic signal:

- The signal facing the vehicle is turned green
- All other signals at the intersection are turned red

This ensures the emergency vehicle can move through the intersection without any delay.

5. Vehicle Movement Monitoring

The system continues to monitor whether the emergency vehicle has passed through the intersection or not.

6. Restoring Normal Signal Operation

Once the vehicle has passed the intersection:

- The traffic lights return to their regular cycle
- The system waits for the next intersection to be detected

7. This Process Repeats Automatically

The same logic is applied continuously to each traffic signal along the vehicle's route.

RESULT

The Emergency Vehicle Guidance System was tested in traffic simulations using ESP32 controllers at intersections and GPS tracking on the emergency vehicle. The system correctly found the real-time location of the emergency vehicle and changed the traffic lights to green in its direction while turning red for all other lanes. During testing, the average time the emergency vehicle had to wait at intersections dropped a lot, making the response faster than usual traffic conditions. The system showed strong wireless communication, quick response times, and smoothly returned to normal traffic light settings after the vehicle passed.

CONCLUSION

The proposed Emergency Vehicle Guidance System (EVGS) tackles a major problem in city traffic — slow emergency responses caused by heavy traffic.

By using GPS tracking, Internet of Things (IoT) communication, and automatic traffic signal control, the system gives emergency vehicles priority in real time.

This helps them reach their destination faster, which can save lives.

This project sets the stage for creating smarter, more advanced traffic systems in cities that use automation, connected devices, and quick decision-making.

FUTURE SCOPE

1 - The system also includes using drones along with sirens and flashing lights.

2 - It connects with AI and Machine Learning to predict and clear paths for emergency vehicles.

3 - 5G and V2X communication technologies are used to make responses faster and with less delay.

4 - A central smart city traffic network is set up to coordinate traffic signals at multiple intersections.

5 - Emergency drones are used to monitor accident sites automatically.

6 - Cloud-based dashboards are used to track and analyze traffic performance data.

REFERENCES

1 - A.Kumar, "IoT-Based Intelligent Traffic Signal System," IEEE Access, 2021.

2 - S.Sharma et al., "GPS and GSM Based Vehicle Tracking and Control System," IJET, 2020.

3 - D.Singh, "Smart City Traffic Management using IoT," International Journal of Emerging Tech, 2022.

4 - M.Patel, "Emergency Vehicle Priority System Using Wireless Communication," IJSER, 2023.

5 - MQTT.org Documentation — "MQTT Protocol Overview."

6 - Arduino.cc Documentation — "GPS and IoT Integration Projects."